

# PATENT SPECIFICATION

629,098



Convention Date (United States of America): Dec. 29, 1945.

Application Date (in United Kingdom): Nov. 21, 1946. No. 34504/46.

Complete Specification Accepted: Sept. 12, 1949.

Index at acceptance:—Classes 43, C1g; and 89(ii), A1b.

## COMPLETE SPECIFICATION

### Improvements in or relating to Fastening Devices such as Rivets and Bolts

We, HUCK MANUFACTURING COMPANY, a corporation organised under the laws of the State of Michigan, United States of America, of 2480, Bellevue Avenue, Detroit, Michigan, United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to fastening devices such as rivets and bolts for fastening elements together.

The present invention generally comprises a two-part fastener including a bolt-type pin having a preformed head adapted to be inserted from one side of the work and a collar on the pin at the opposite side of the work which is to be locked to the pin. This fastener is set by pulling the pin and applying the reaction force to the collar and after a certain pulling force is reached, the collar is locked to the pin by flowing metal into locking grooves in the bolt. Subsequently the pin is broken under tension at a weaker section adjacent the collar.

An object of the invention is to provide a simple form of fastener such as mentioned which may be set by means of mechanism adapted to pull the bolt and to apply the reaction force against a collar on the bolt.

Another object of the invention is to provide a fastener of this character which when set tightly, holds the parts together with the bolt in tension so as to insure continued tightness of the fastener during use.

Another object of the invention is to provide a fastener of this type which may be manufactured and applied inexpensively.

For a better understanding of the invention, reference may be had to the drawings wherein:

Figure 1 is a cross-sectional view illustrating a fastener assembled with the work prior to any rivet setting operation, in accordance with one form of the invention;

Fig. 2 illustrates the use of mechanism in setting the fastener shown in Fig. 1;

Figs. 3, 4 and 5 are views similar to Fig. 1 illustrating fasteners constructed according to other forms of the invention;

Fig. 6 is also on the order of Fig. 1 but shows a fastener having a flush type collar or head;

Fig. 7 is a fragmentary view showing a fastener constructed according to another form of the invention;

Figs. 8 and 9 show a fastener having means for retaining it in an opening while initially applying the setting mechanism thereto; and,

Fig. 10 is a view similar to Fig. 1 illustrating a fastener having axial corrugations.

Referring to Fig. 1, the pin or locking bolt is indicated generally at 10 and is shown as extending through openings 11 in a pair of plates 12 and 13. The pin has a head 14 adapted to engage one side of the structure being fastened, a cylindrical hole filling portion 15 next to the head, and a grooved portion 16 next to the portion 15, having a series of annular ribs 17 and groove bottoms 18. The outer diameter of the ribs 17 is less than the outer diameter of the hole filling portion 15, and between the latter portion and the grooved portion 16, the shank has a conical taper or shoulder 19. It is desirable to use the fastener in structural openings smaller than the maximum diameter of the hole filling portion 15, but the openings should be slightly larger than the ribs 17 so that the pin may be easily inserted. Therefore, when the pin is manually inserted, the hole filling portion 15 will not enter the openings 11 and the pin is in the position

shown by Fig. 1. In connection with head 14, an annular undercut or recess 20 is formed in the face thereof so as to provide a space to accommodate burrs or the like which possibly at times may be present at the edge of opening 11 in the plate 12. This allows the head to seat against the plate even though burrs may be present and also provides a space to accommodate "puckering" of plate 12 if the hole expands during hole filling.

At the end of the grooved portion of the pin, the latter has a groove or breakneck 21 of smaller diameter and this is the weakest part of the pin so that the pin will break under tension at this location before it will break under tension at any other location. Next to the breakneck, the pin has a cylindrical portion 22 of substantial length which may be of slightly reduced diameter as compared to the ribs 17 and this portion terminates at its outer end in a grooved gripping portion 23.

A second part of the fastener comprises a collar or head 24 which may be moved over the pin and located against the plate 13 as shown, and this collar is adapted to be radially contracted or swaged into the grooves 18 of the pin so as to lock the collar thereto and form a head against the plate. With particular reference to Fig. 1, the collar initially is formed with a conical surface 25 which makes an angle of about 30° with the horizontal axis, and this surface at its larger end joins one end of a cylindrical surface 26. At the other end of the latter, the collar has a cylindrical surface 27 of smaller diameter as compared to the surface 26 and the two cylindrical surfaces are joined by a tapered shoulder 28. This construction of collar provides an annular bead constituting that portion of the collar whose diameter is greater than the diameter of surface 27. The opening in the collar is slightly larger than the ribs 17 and portion 21 of the pin to provide a desirable clearance which allows slight collar contraction without interfering with axial motion of the pin.

The fastener is set by means of riveting mechanisms which as shown by Fig. 1 herein, may comprise an anvil 29 having an inner frusto-conical surface 30 making an angle of 60° to a plane normal to the axis of the pin and adapted substantially to fit the collar surface 25 and an outer frusto-conical surface 31. At its smaller end, the angled surface 30 on the anvil joins a short cylindrical bore 32 and the length of the latter is such as not to provide an undesired frictional resistance to extrusion of the collar through the anvil. In order to grip the grooved portion 23 of the pin, jaws 35 are provided and these are

adapted to be contracted and moved by a jaw contracting and moving sleeve element 36. When the jaws 35 and member 36 move to the right so as to pull the pin, the reaction to any pull is applied through a barrel or sleeve 37 and then through the anvil 29. After the pin 10 is inserted through the plates 12 and 13, as shown in Fig. 1, the collar 24 is located on the pin, and then the mechanism is moved over the pin until the grooved end portion 23 is located between the jaws 35. Initial operation of the mechanism causes the pin to be pulled and the flared mouth portion 30 of the anvil to move into contact with the conical surface 25 on the collar so as to press the collar against the plate 13.

With the collar against the plate 13 and the jaws gripping the pin, further pull on the pin will cause the hole filling portion to wiredraw down to a smaller diameter and move into the openings 11 in the plates and this continues until the head 14 reaches plate 12. It is to be realized however that depending upon relative hardness of metals involved, the hole filling portion of the pin may more or less wiredraw down to a smaller diameter and the opening may more or less expand accordingly. In any event the hole filling portion of the pin will have an interference fit in the opening or in other words, the fit will be such as caused by one interfering metal giving way to the other. During the foregoing procedure, the plates may be pulled together if separated since the collar is being pressed against plate 13 while the hole filling portion 15 is applying force against plate 12 due to the wire-drawing action. It is evident that the plate 12 in particular acts as a wiredrawing die when the shank portion 15 draws down to the original or to a somewhat expanded hole diameter.

With respect to hole filling, this result will be obtained providing the opening 11 is at least not larger than the shank portion 15 and regarding wiredrawing, the extent thereof will depend upon variable factors. In certain instances, the metal in the plates may be of such character that the openings 11 will expand or enlarge as the hole filling portion 15 moves through the plates. Again, variable degrees of wiredrawing and hole expansion may be obtained depending upon the relation of metals employed. It seems preferable, however, to have the hole filling portion of the pin characterized by a resistance to wiredrawing which is less than the resistance to expansion of the plate metal so as to effect wiredrawing of the shank portion at least largely. This is desirable as there naturally will be less distortion of the plates.

When the mechanism is initially actuated to pull the pin and apply the reaction to the collar 24, the anvil surface 30 alone will contact the surface 25 on the collar. As the pull on the pin and reaction force increases, the resistance of the collar to swaging movement of the anvil surface over the surface 25 will be overcome and the anvil surface 31 will progressively contact more of the surface 25 on the collar and in doing so, the angularity of the latter will progressively change to fit the anvil surface 31 until finally the collar fits both tapers on the anvil. During such movement of the anvil over the collar, the end of the latter also begins to extrude through the central opening 32 of the anvil. Generally, therefore, the resistance to such movement of the anvil increases during this early movement until both angles on the anvil fit the collar.

The extent of early movement of the anvil towards that position where both anvil surfaces first fit the collar depends upon the forces required to fill the hole. It may be that the anvil would not move or only a small amount during the hole filling stage in one instance, and in another, the anvil may move until both angles on the anvil fit the head. The sequential relation of hole filling and early anvil movement is not important providing appreciable swaging of the collar radially inwardly towards the pin, at least not to exceed the clearance between ribs 17 and the bore of the collar does not occur until the hole is filled and the plates are drawn tightly between the head and collar. In other words, it is not desired to effect locking of the collar to the grooved portion 16 of the pin until the hole is filled and the plates are drawn tightly together. In order to allow minor swaging movement of the metal towards the pin, such as that swaging which would occur until both angles on the anvil fit the collar, the latter has its opening sufficiently large as to provide enough clearance between the collar and pin to accommodate minor radially inward movement of the metal towards the pin without effecting any lock between the collar and pin.

It is desirable that the collar have a high initial resistance to swaging after it is reformed to fit both angles on the anvil and that this resistance be sufficient to allow the hole filling operation and drawing of the plates tightly together by the head 14 and collar before the swaged lock is effected. After the force on the anvil is sufficient to overcome this high initial resistance to swaging and to cause the bead on the collar to give way, it is desir-

able that the final resistance prior to engagement of the anvil with the plate 13 be substantially the same as or at least not much greater than said high initial resistance to swaging.

Variation in the high initial resistance to swaging may be effected by varying the diameter of the bead or by varying the axial location of taper 28 on the collar so as to vary the axial length of the bead on the collar or by varying both dimensions. The length of the base of the bead largely determines the high initial resistance to swaging and its length may be varied to secure the desired results. Variation in the final resistance to swaging may be effected by varying the diameter of the cylindrical portion 27 of the collar and a decrease in this diameter reduces the final resistance to swaging whereas an increase in diameter increases the final resistance to swaging. Once swaging is started after said high initial resistance to swaging is overcome, it will continue although the resistance will again increase during the final stage of movement of the anvil.

The swaged lock between the collar and the grooved portion 16 of the pin is effected after the pull on the pin and reaction force on the collar are sufficient to complete the hole filling operation and to draw and clamp the plates tightly together between the head 14 and collar, and it is apparent since the swaged lock is effected while the pin is under considerable tension, that the fastener will continue to hold the plates tightly connected. After the lock is effected, increased pull on the pin will break it at the breakneck 21 and thereafter operation of the mechanism is reversed so as to cause a nose 38 on the sleeve 36 to eject the collar from the anvil.

The same operation may be effected even though the total thickness of plates 12 and 13 vary considerably since the substantial length of the grooved portion 16 will still insure locking of the collar to one or more grooves. If the plates were decreased in thickness from that shown, the broken end of the pin would project outwardly from the collar whereas any increase in the thickness of the plates would cause the breakneck to be located axially within the collar. The fastener may thus be used for connecting structures wherein the thickness of the latter varies through a substantial range. While the anvil 29 is shown as having the two angles 30 and 31, under certain conditions it may be desirable to have a single angle 30 so that the latter would fit the entire collar surface 25 initially.

The construction shown by Fig. 3 is substantially similar to that shown by Fig. 1

excepting that the head 14 has an undercut 39 which provides space for an annular sealing ring 40 formed from rubber or other suitable material such as soft metal subject to plastic deformation, which may be desired under certain conditions as for instance where the hole in the plates happens to be larger than the pin portion 15. The fastener is set in the same way but in this case, the sealing ring will be flattened and strongly brought into sealing contact both with the pin and plate 12 before the head directly engages the plate. Preferably and in order to insure direct contact of the outer portion of the head with the plate 12, the volume of the space defined by the undercut in the head is greater than the volume of the ring.

Also in this figure the collar 24 is initially formed with two conical surfaces 41 and 42 shaped to fit the anvil surfaces 30 and 31. Hence, in this case the anvil would not initially move to reform the surface of the collar to fit the anvil surfaces but would fit such surfaces as soon as the anvil moves against the collar.

In the construction shown by Fig. 4, a different head is provided on the pin and this head joins the hole filling portion 15 by means of a frusto-conical portion 43. When this fastener is set, the frusto-conical portion 43 is forced into the end of the opening in plate 12, and this may be desirable in the event a positive metal seal is desirable.

In Fig. 5 the fastener has a frusto-conical head 44 and in this case the opening in plate 12 will be countersunk as indicated at 45 so as substantially to fit the head and provide a flush condition, or again the plates could be dimpled to provide the recess for the head.

Now referring to Fig. 6, the fastener shown in this figure is adapted particularly to effect flush riveting at that side from which the bolt is driven or pulled. In this case, the pin may have different preformed heads but is shown as having the same head as indicated at 14 in Fig. 1. Also the pin has a hole filling portion 15 such as in Fig. 1 and next to the portion 15, it has an annular locking groove 46. This locking groove joins a cylindrical land 47 which is next to a breakneck groove 48. The plate 13 is provided with a countersunk recess 49 adapted to receive a collar 50, and the recess in conjunction with the locking groove 46 forms a locking space into which the collar may be forced.

In setting this fastener, a different type of setting mechanism may be employed which may correspond generally to that shown in Fig. 9 of Patent No. 426,635. Initially, the reaction force is applied to the sheet 13 by means of an outer anvil

and then after the pull on the pin and the reaction force reach a certain amount necessary to cause the hole to be filled and the plates drawn tightly together, continued pull on the pin causes the collar to be forced into the locking recess while the pin is under tension and with the head 14 and collar strongly holding the plates together. Thereafter, increased pull on the pin will break it at the breakneck 48.

Fig. 7 shows a bolt having a head 55 of frusto-conical form adapted to seat in a countersunk recess 56 in plate 12 and additionally the bolt has a flared portion 57 generally corresponding to the flared portion 43 in Fig. 4 which is adapted to seal the end of the pin in the opening as it forces its way into the opening. Also in this construction, the collar is shown divided at the end of the head to provide two parts indicated at 62 and 63, which jointly correspond to the collar 24 previously shown. This collar is adapted to be swaged by the anvil in the same manner as previously described. Dividing the collar enables substituting collar sections of varying diameters for the section 63 and thereby varying the swaging resistances. Also various sizes of sections may be substituted for section 62 for similar reasons and also to facilitate fabrication.

According to Fig. 8, the pin instead of having a hole filling portion 15 as previously described, has one or more annular heads 65 in the pin portion adapted to be located in the plate openings. This form of the invention is adapted to be used particularly where the operator cannot by hand hold the headed end of the pin in place while applying the mechanism to the other end of the pin. The ribs or beads are of such character that by striking the head 14 in Fig. 8 with a hammer or the like, the beaded portion of the pin can be driven into the hole so as to hold the pin in place as seen in Fig. 9. During this driving of the pin into the openings, the beads bend over as seen in Fig. 9 but necessarily have a strong frictional lock with the side wall defining the opening so as to prevent the pin from falling out when the mechanism is applied to the grooved end of the pin. For instance, the pin may be inserted in large plates from one side and lodged therein by a hammer blow and then the operator can go to the other side of the plates and apply the mechanism. The beads may be formed by rolling operations which form the beads and simultaneously form annular grooves indicated at 67 and such grooves provide a space into which the beads may bend as seen in Fig. 9.

In Fig. 10, the pin is similar to that shown in Fig. 1 excepting that it has the

hole filling portion provided with axial ridges or corrugations 70. When this bolt is applied, the ridges individually are flattened out circumferentially as they move into the opening and the metal flows or moves into the valleys between the ridges. Depending upon the size of the opening, more or less ridge metal will flow into the valleys and if the opening is of optimum size it should substantially be filled. Preferably the relation of the metal hardness in the plates and pin is such that the ridges will flatten and fill the valleys and then wiredraw down or expand the hole if necessary before either cutting of the plates by the ridges or shearing of the ridges by the edge of the plate opening will occur.

Although more than one form of the invention has been illustrated and described in detail, it will be apparent to those skilled in the art that various modifications may be made without departing from the scope of the claims.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A fastener comprising a pin adapted to extend through and substantially fill an opening in a plate structure and having a head at one end for directly engaging one side of the structure, an axial portion next to the head and adapted to extend through the opening, an externally grooved locking portion next to the axial portion, and a stem portion at the end opposite the head for facilitating gripping and pulling the pin, and a collar adapted to be disposed on the grooved portion of the pin at the side of the structure opposite that to which the head is engaged, and to be contracted into said grooved portion when the fastener is set.
2. A fastener for connecting members together comprising a pin having a head at one end for directly engaging one side of the members to be connected, a cylindrical axial portion next to the head adapted to be disposed in and substantially fill an opening through the members, an externally and circumferentially grooved locking portion axially next to the cylindrical portion, a cylindrical stem portion axially next to the grooved portion, and an annular collar adapted to be disposed on the grooved portion of the pin at the side of the members opposite that to which the head is engaged, said fastener being adapted for setting by pulling said stem portion and applying the reaction to the pull against the collar so as to swage the latter into interlocking engagement with the grooved portion of the pin.

3. A fastener according to claim 1 or 2, in which the pin is adapted to break under tension after the collar has been swaged or upset into the grooved portion.

4. A fastener according to claim 1, 2 or 3, in which a breakneck is provided adjacent the grooved locking portion for defining a breaking portion when the pin is tensioned sufficiently to effect breakage at said breakneck.

5. A fastener according to claim 4, in which the breakneck is annular and of reduced diameter and is located between the stem portion and the grooved portion.

6. A fastener according to any one of the preceding claims, in which the diameter of the axial portion adjacent the head is greater than the maximum diameter of the grooved portion so as to fill the opening when the fastener is set.

7. A fastener according to any one of the preceding claims, in which one or more radial projections, or one or more annular ribs, is provided on the axial portion adjacent the head and adapted to deform axially when the pin is first pushed through the opening so as to hold the pin in place.

8. A fastener according to any one of the preceding claims, in which the stem portion has pulling or gripping grooves.

9. A fastener according to any one of the preceding claims, in which the collar has an axially tapered annular surface (i.e. a frusto-conical portion), a cylindrical portion axially spaced from said tapered surface, and an annular bead between said tapered surface and said cylindrical portion and preferably having a cylindrical outer surface of larger diameter than said cylindrical portion.

10. A fastener according to claim 9, in which the bead has an axially tapered end surface joining the cylindrical outer surface of the bead to said cylindrical portion of the collar.

11. A fastener according to claim 10, in which the angle of taper on the end surface of the bead is different from and preferably greater than the angle of taper of the surface on the collar next to the bead.

12. A fastener according to any one of the preceding claims, in which the section of the pin between the head and collar is in a state of substantial tension and has an interference, or wire drawn, press fit in the opening when the fastener is set.

13. A fastener according to any of the preceding claims, in which the end of the opening of the side of the structure engaged by the collar is outwardly flared and the locking groove on the pin and the collar are within the flared portion of the opening.

14. A fastener according to claim 13, 130

in which the collar substantially fits the flared portion of the opening.

15. The method of fastening a plate structure which comprises providing a pin with an abutment adapted to directly engage one side of the structure, an axial portion adapted to extend through and substantially fill the opening in the structure, a locking groove in the external surface of the pin axially next to said axial portion, inserting the pin into the opening, applying a collar on the axial portion at the side of the structure opposite that to which the abutment is engaged, then pulling the pin and applying the opposite reaction to the collar so as to clamp the structure between the abutment and collar, and then locking the collar to the locking groove while maintaining a pull on the pin.

16. The method according to claim 15, in which a grip portion is provided axially outward of the locking groove, the pin being pulled at said grip portion.

17. The method according to claim 15 or 16, in which the pin is pulled and the opposite reaction is applied to the structure by an anvil so as to clamp the structure between the abutment and said anvil.

18. The method according to claim 15, 16 or 17, in which the collar is radially swaged into the locking groove by means of the reaction force.

19. The method according to any one of claims 15—18, in which a portion of the collar is forced into the locking groove.

20. The method according to any one of

claims 15—19, in which the axial portion is adapted substantially to fit the opening in the structure.

21. The method according to any one of claims 16—20, in which the axial portion is larger than the opening in the structure, the pin is inserted through one end of said opening until the grip portion is beyond the other side of the structure, the collar is placed on the pin at the last-mentioned side of said structure, and the pulling of the pin causes the axial portion to move into and fill said opening with an interference fit and the abutment to engage the said structure.

22. The method according to any one of claims 15—21, in which the collar is locked to the pin in a position against the structure.

23. A fastener substantially as hereinbefore described and with reference to any one of Figs. 1, 3, 4—7, 8 and 10 the accompanying drawings.

24. The method of fastening a structure substantially as hereinbefore described and with reference to the accompanying drawings.

Dated the 21st day of November, 1946.

For: HUCK MANUFACTURING  
COMPANY,

Stevens, Langner, Parry & Rollinson,  
Chartered Patent Agents,  
5/9, Quality Court, Chancery Lane,  
London, W.C.2,

and at  
120, East 41st Street, New York, 17,  
New York, U.S.A.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1949.

Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies, price 2s. 0d. each (inland) 2s. 1d. (abroad) may be obtained.

[This Drawing is a reproduction of the Original on a reduced scale.]

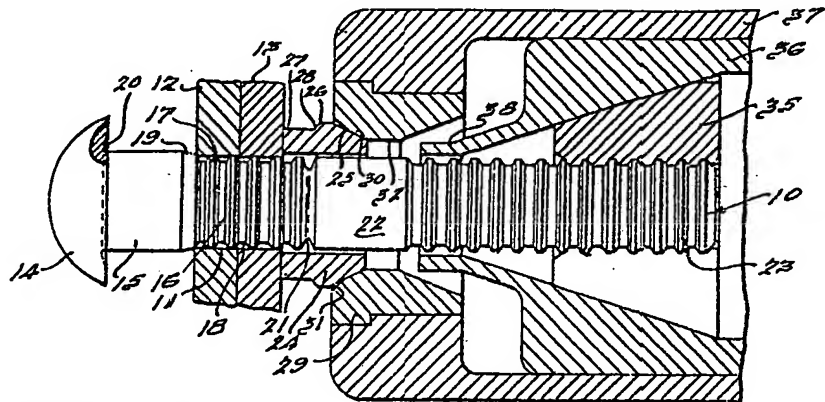


FIG. 1.

FIG. 2.

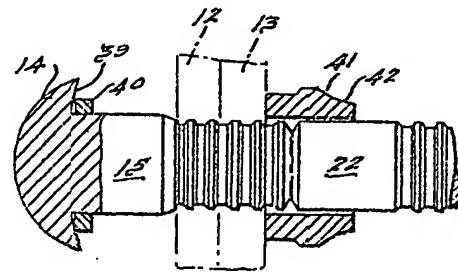
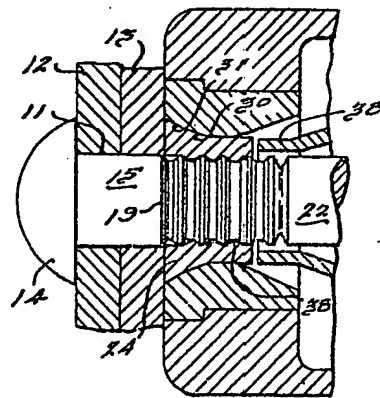


FIG. 3.

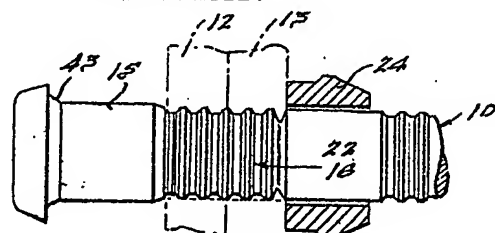


FIG. 4.

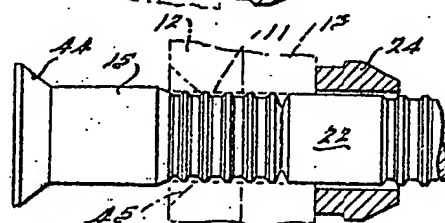
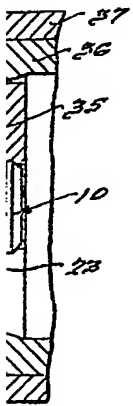


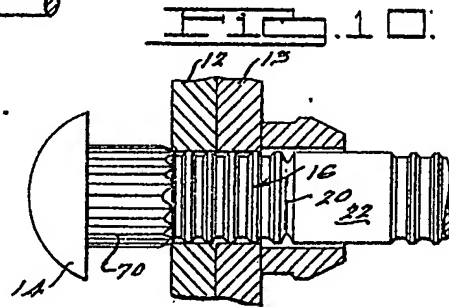
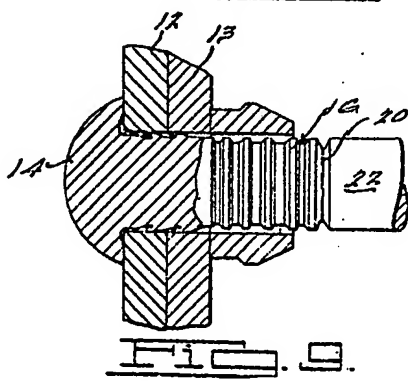
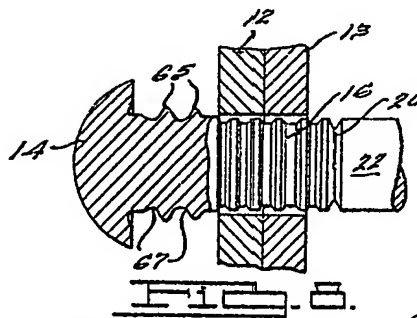
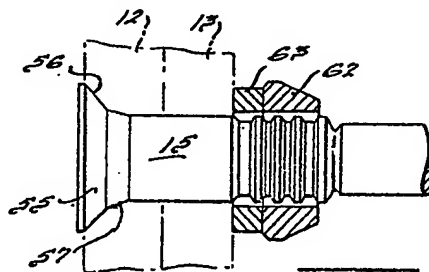
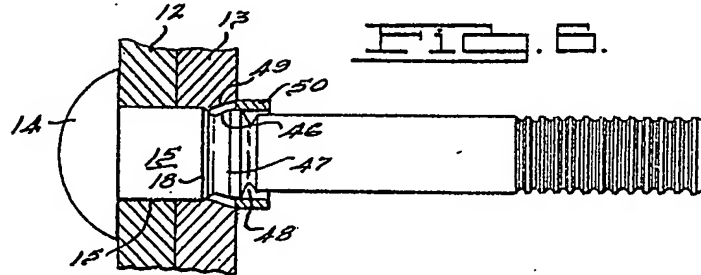
FIG. 5.



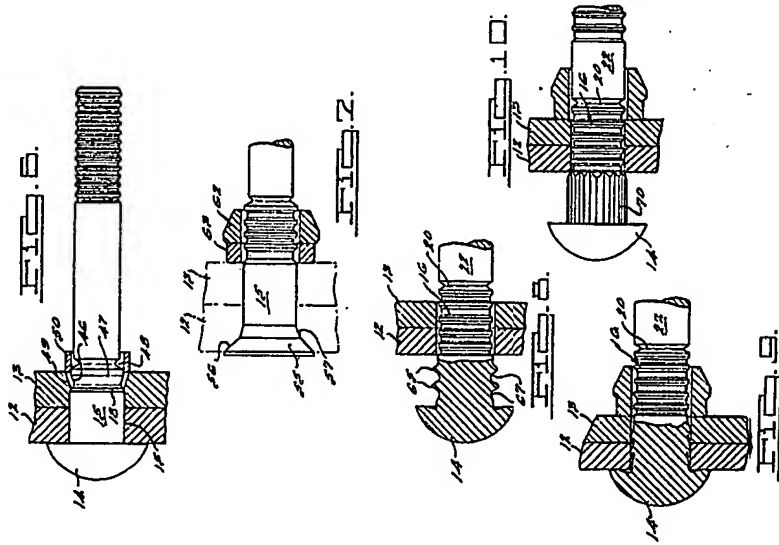
42



1.







[This Drawing is a reproduction of the Original on a reduced scale]